CHIEF JOSEPH

KOKANEE ENHANCEMENT PROJECT

CONFEDERATED TRIBES
OF THE COLVILLE RESERVATION

1997 ANNUAL REPORT

PREPARED FOR

CHARLIE CRAIG, C.O.T.R. 95-11

BONNEVILLE POWER ADMINISTRATION
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BONNEVILLE POWER ADMINISTRATION
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EXECUTIVE SUMMARY

The determinations of the status of natural production kokanee salmon, the landlocked form of Sockeye salmon (*Oncorhynchus nerka)* will include a spawner escapement study done through adult enumeration [Objective I], genetic determination [Objective II], egg to fry survival [Objective III] and entrainment rates through Grand Coulee Dam [Objective IV]. The completed objectives will allow more effective management of the fisheries resource in Lake Roosevelt. The goal of the project is the protection and enhancement of the natural production kokanee above Chief Joseph and Grand Coulee Dams. The application of four distinct methodologies as objectives of the project will determine the status of the natural production kokanee found in the waters of Lake Roosevelt and Lake Rufus Woods. A secondary outcome of this project will determine if the natural production stock is genetically unique and acceptable for utilization in the current BPA sponsored hatchery programs.

Objective I, spawner escapement is the assessment and evaluation of the natural production kokanee spawning escapement in streams tributary to Lake F. D. Roosevelt and Rufus Woods Lake. The streams of interest include, Big Sheep Creek, Barnaby Creek, the San Poil, Nespelem and Kettle rivers. While these five streams are the primary focus, other streams or locations may be assessed if spawning kokanee are present.

Objective II, genetic determination will be performed using appropriate starch-gel electrophoretic analysis. The samples for analysis will be obtained from recovered spawned out kokanee carcasses, gill net samples, and samples obtained from British Columbia waters. The process of electrophoresis will be contracted to determine if tributary spawning kokanee are genetically unique while comparing them genetically to hatchery and other existing stocks.

Objective III, egg to fry survival, is the determination of egg to fry survival rates in each project stream and comparing these values to other values in literature. This will enable the determination of the contribution made to the Lake Roosevelt, Lake Rufus Woods fishery by the natural production kokanee component.

Objective IV, dam entrainment, is the determination of fish

entrainment rates and annual totals as well as identify powerhouse, and dam operation responsible for highest entrainment. In addition, data analysis will answer questions relating to diel distribution, horizontal distribution, vertical distribution, identify weekly and monthly entrainment peaks through Grand Coulee Dam. Data collection will involve the use of appropriate hydroacoustic technology. Recent reports substantiate the presence of kokanee and rainbow trout from Lake Roosevelt at downstream salmon counting facilities. Floy tag return information also documents the presence of kokanee and rainbow trout in lower reaches of the Columbia River. In addition, the Bonneville Power Administration funds hatcheries located at Sherman Creek and at Chamokane Creek on the Spokane Indian Reservation, for several years these hatcheries have been have been out planting Lake Whatcom origin kokanee. The interaction of these fish on natural production kokanee is not fully understood.
These indicators mandate the necessity of hydroacoustic entrainment assessment. The hydroacoustic contract was designed specifically to enumerate the number of fish targets per hour, week, month, diel period, seasonal period and horizontal, vertical, and spatial distributions. Target strength analysis may determine probable fish size. A fish target is a sonar signal sent and received from a transducer operating under water using predetermined criteria for rates of sampling. Tracks or targets are reviewed whereby targets not meeting certain criteria are not counted.

Because hydroacoustics cannot determine the specie of fish as it passes through a turbine intake, concurrently a gill net operation will be carried out in the forebay of Grand Coulee Dam to identify the probable species composition of entrained fish. Variable mesh gill nets will be deployed in both horizontal and vertical orientation as close to the turbine intakes as is safe and practible.

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ABSTRACT

CHIEF JOSEPH KOKANEE ENHANCEMENT PROJECT

Project No. 9501100
Contract No. 95BI35101

In the early 1980's the Confederated Tribes of the Colville Reservation, the Spokane Tribe of Indians and the Washington Dept. of Fish and Wildlife developed a management plan for Lake Roosevelt on the restoration and enhancement of kokanee salmon populations using hatchery out plants and the restoration of natural spawning runs. The plan was incorporated into the Northwest Power Planning Council (NPPC) in their 1987 Columbia Basin Fish and Wildlife program as partial mitigation for hydropower caused fish losses resulting from the construction of Grand Coulee Dam.

The Chief Joseph Kokanee Enhancement Project, as part of a basin wide effort, is evaluating the status of the natural production kokanee in streams tributary to Lakes Roosevelt and Rufus Woods and is examining entrainment through Grand Coulee Dam. The goal of this project is the protection and enhancement of the natural production kokanee in these two lakes. The project is currently collecting data under four phases or parts.

Since 1991, Lake Whatcom Washington origin kokanee have been planted in considerable numbers into the waters of Lake Roosevelt. A natural production kokanee fishery has persisted in the lake since the early 1970's(Cash, 1995), (Scholz, 1991). Historical information alludes to wild Kokanee production in the San Poil River, Nespelem River, Big Sheep Creek, Ora-Pa-Ken Creek, Deep Creek and Onion Creeks. The genetic makeup of the fish within the fishery is unknown, as is their contribution to the fishery. The level of influence by the hatchery out planted stock on wild fish stocks is unknown as well.
Project outcomes will indicate the genetic fitness for inclusion of natural production kokanee stocks into current Bonneville Power Administration funded hatchery programs. Other findings may determine contribution/interaction of/between wild/hatchery kokanee stocks found in the waters of Lake Franklin D. Roosevelt.

1.0 INTRODUCTION

This annual report is submitted as partial substantiation of work accomplished to date on this resident fish research project. The primary species of concern is kokanee or landlocked Sockeye salmon *(Oncorhynchus nerka)*.

There are four objectives associated with this project. The first of which is to determine stock status through spawner escapement studies. The second objective is to determine egg to fry survival and relate the survival to possible contribution of the natural production kokanee to the Lake Roosevelt kokanee fishery.

The third objective is to determine the genetic basis of the natural production kokanee within the two lakes. The fourth objective is to determine dam entrainment rates and totals through Grand Coulee Dam. Hydroacoustic assessment of entrainment through The work will include assessment of adult kokanee spawning escapement, egg to fry survival, genetic determination and entrainment rates through Grand Coulee Dam and identification of hydropower operations, power plant, etc., responsible for entrainment. The area of study will include Lake Roosevelt and its tributaries, Lake Rufus Woods and its tributaries and tributaries to the upper Columbia River within British Columbia. This project is a stock assessment project that will enumerate the number of natural production kokanee returning to spawn in tributary streams, locate and identify all known kokanee populations (Objective I). Objective II, determine the egg to fry success of the natural production kokanee. This will aide in the assessment of the contribution of natural production kokanee to the fishery of Lake Roosevelt. Objective III, determination the genetic make-up of the natural production kokanee. This work will be carried out by collecting biological samples from spawned out carcasses and other sources and contractually conducting electrophoretic analysis to determine their genetic make-up. Objective IV, a dam entrainment study will determine entrainment rates through Grand Coulee Dam and identify specifics such as annual entrainment, diel, horizontal and vertical distribution and identify the operation or powerhouse responsible for the entrainment. Entrainment rates will be determined using appropriate hydroacoustic techniques provided by and outside contractor specializing in this field.

Concurrently, a weekly gill net survey will determine the probable species composition of the entrained fish, knacks, species composition will determined through a series of weekly gill net operations.

The Confederated Tribes of the Colville Reservation have been working cooperatively with the Spokane Indian Tribe and the Washington Department of Fish and Wildlife in fisheries enhancement programs for Lake Roosevelt. This project will complement the existing kokanee projects currently funded through the Northwest

Power Planning Council's Fish and Wildlife Program, Section 903(G)(1)(C).

1.1 HISTORICAL BACKGROUND

Since the construction of Grand Coulee Dam in 1930's and Chief Joseph Dam in 1956, the anadromous fishery above these structures has been completely and forever blocked. The reservoir and river areas above Chief Joseph and Grand Coulee Dams are now exclusively made up of resident fish.[Resident fish species of natural and hatchery origin account for the total take of recreational, sport, and subsistence fisheries.] Species of interest include but are not limited to rainbow trout *(Oncorhynchus mykiss)*, white sturgeon *(Acipenser transmontanus)*, Walleye *(Stizostedion vitreum)*, small mouth bass (Micropterus *dolomieui)* and kokanee *(Oncorhynchus nerka)*. One species of special interest is the land-locked Sockeye salmon or kokanee.

Lake Roosevelt National Park Service and Washington Department of Fish and Wildlife information indicate that Lake F. D. Roosevelt is used intensively by recreational users and sport fishers. The resident fishery is also important to the membership of the Confederated Tribes of the Colville Indian Reservation for subsistence fishing.

Sources at the Rock Island fish counting facility indicate the passage of Sockeye smolts through their facility (Tilson, pers. corn. 1996). Eastern Washington University floy tag studies document substantial entrainment of Lake Roosevelt produced fish through out the lower system.

During the early 1970's a kokanee salvage fishery was documented by the National Park Sevice (Cash. per. corn. 1996) and the Washington Department of Fish and Wildlife (Duff. per. corn. 1996)below the tailrace area of Grand Coulee Dam, success was measured in apple boxes per day (Cash, Pers. Corn. 1996).

The adoption of the Lake Roosevelt Fisheries Enhancement Program by the Northwest Power Planning Council resulted in the construction of two kokanee hatcheries. One of these hatcheries is located at Sherman Creek near Kettle Falls, Wa. and is operated by the Washington Department of Fish and Wildlife, the second hatchery is located on the Spokane Indian Reservation near Ford, Wa. and is operated by the Spokane Tribe of Indians. In 1991 these two hatcheries began releasing kokanee as part of a supplementation program. Full production of these facilities has not been reached due in part to insufficient rearing capability at either hatchery. The present kokanee supplementation program does not consider enhancement efforts using natural production kokanee stocks or maintenance of their genetic integrity.

A small natural production kokanee fishery exists in several small tributary streams to Lake Roosevelt Woods and Lake Rufus Woods. The origin, strength, and genetic make-up of these kokanee populations is unknown, as is their contribution to the resident fishery. Kokanee populations in Lake Roosevelt are affected by annual water regimes which influence and control food production and entrainment (Scholz et. al. 1985, Griffith and Scholz, 1990, Peone et. al. 1989, and McDowell and Griffith, 1993.

The Chief Joseph Kokanee Enhancement Project findings from 1996 and 1997 indicate that a substantial number of fish of unknown species are entrained annually through Grand Coulee Dam. The amount of entrainment, it's timing, duration and hydropower operations that influence entrainment is also unknown.

In an effort to effectively manage natural and hatchery production kokanee populations in Lake Roosevelt and Lake Rufus Woods, several unknown critical factors must be evaluated. In addition to hydropower related entrainment, the contribution of wild production kokanee to the resident fishery, the genetic make up of the wild production kokanee, the annual escapement of adult spawners to tributaries and the species composition of the entrained fish numbers will be determined.

Recent literature reviews (LeCaire, 1995) combined with creel census information indicate that the majority of the Kokanee brought to the creel are of natural origin, although their genetic lineage is for now unknown.

1996 and 1997 adult escapement figures from known natural production kokanee populations have plummeted since 1995. Adult returns to the San Poil and Nespelem rivers are much reduced from 1995. Barnaby Creek and Big Sheep Creek returns are reduced as well.

2.0 METHODS AND MATERIALS

2.1 Spawner Escapement,

Native Americans in this region have used a picket fence type of weir for hundreds of years (Ray, 1972). The use of picket fence type weirs is an established trapping method utilized by fisheries personnel in several states including Washington state (Blankenship, et al. 1980) (Mullins et al. 1991),(Hunter, 1954). The Lake Roosevelt Rainbow Trout Habitat Passage/Improvement Project has successfully used a picket fence type of weir and holding box for capture and enumeration of adfluvial rainbow trout in tributaries to the San Poil River (Peone, personal Corn.). The Chief Joseph Kokanee Enhancement project elected to use the same design.

A large holding box, 3 ft. wide by 3 ft. deep by eight feet long is constructed out of 1 1/8 inch heavy wall aluminum tubing. The tubing is spaced on a 1 in. center so larger fish cannot pass between pickets. This spacing prevents upstream migration while allowing juvenile to pass downstream. All tubing joints are welded into place using a mig welder. The live well is assembled on site before being placed in the stream. It is then anchored to the substrate on each corner using 5/8 in. iron re-enforcing bar driven into the substrate. A pair of small picket panels are placed into the down stream end in the form of a V. A second pair of small picket panels are placed inside the live well to help prevent escape. In areas of heavy flow a small piece of plywood is placed on the outside of the upper end of the live well to provide slack water so that fish may rest. Following the installation of the live well in a selected area that allows shade and water cover, tripods made of 4 in. heavy gauge angle iron are placed diagonally downstream from the live well. These tripods are five feet long and function as fence posts when installed along an imaginary line from bank to bank. Once the tripods are placed in a suitable anchored position, a pair of cross bars (angle iron) are attached horizontal to the tripods using chain and wire. Each five foot cross piece has a series of holes (22) drilled in them. Following the attachment of the cross pieces, five foot aluminum pickets are placed down through each pair of cross pieces. This forms a picket fence that fish follow up to and into the live well.

2.2 Egg to Fry Survival

The method employed during Part II of the study (Egg to Fry

Survival) was the use of redd camp devices as described by Fraley, 1986 and Conlin and Tutty, 1979. The redd cap devices are constructed out of ½ in by 4 inch flat iron, each flat iron is cut 1 meter in length, drilled at each end and bolted together in the form of a square. An additional hole is drilled into two of the corners that permit a 5/8 in re-bar to be driven through into the substrate. This anchors the device into place. A tapered 3/16 inch mesh nylon net is attached to the square using a combination of hot glue, stove bolts and plumbers tape. The tapered net is sewn to produce a four inch cod end that has a one liter plastic bottle attached. The sample bottle was constructed by cutting off the bottom and attaching a small plastic funnel in an inverted position to form a cone leading to the holding/capture bottle. Prior to installation of the funnel/cone, section of the funnel were removed and replaced with netting. Once installed, it is not necessary to remove the holding bottle from the net every visit to check for samples. The person holds the bottle with the bottom down over a bucket and un screws the top allowing any captured fish to fall into the bucket for enumeration, etc.. The bottle and cod end of the net are then returned to the stream.

A second methodology employed to assess juvenile emigration required the installation of a five foot, E. G. Solutions, rotary screw trap. The trap is installed near the mouth of the San Poil river and fished or varying lengths of time dependant upon flow conditions present in the San Poil River. The trap is deployed in the thalweg of the stream. Project personnel check the trap three times per day or more dependant upon sampling success.

2.3 Genetic Determination.

Starch gel electrophoresis of animal proteins is an established methodology for stock status determination (Winans, et al., 1996), (Waples, 1993). Dead spawned out carcasses were obtained from all streams as available. Samples were kept on ice until dissected. Dissection includes removing the head, liver, egg or gonad material and placing it in a labeled plastic bag. Samples are placed on ice until freezing and kept frozen until sent to the contracting lab. Electrophoretic analysis is conducted by Dr. Robb Leary of the University of Montana's "Wild Salmon and Trout Genetics" lab. using standard starch gel-plate methods

2.4 A, Hydroacoustic Evaluation of Fish Entrainment at Grand Coulee Dam, WA.

The objective is to determine fish entrainment rates and annual totals through Grand Coulee Dam. Contract specifics are to determine horizontal and vertical distribution, diel distribution, daily, weekly and monthly peaks, and identify powerhouse and operation responsible for highest entrainment (firm power commitments, power peaking or flood control) for fish ranging from 50 mm to 500 mm in length. Contract bids were requested from several Hydroacoustic sensing companies. Hydroacoustic Technologies Inc. of Seattle submitted a bid using dual beam equipment. BioSonics Inc. of Seattle submitted a much smaller bid using single beam technology and was selected as the contractor.

The contractor is using three, single-beam fixed location acoustic systems to meet the objectives of this study. This utilizes a separate system for each powerhouse. These techniques are similar to those used at Wells Dam (Kudera et al. 1992) and are explained by Thorne and Johnson (1997). Specifics pertaining to the operation of the system are as follow.

Single-beam transducers (420kHz) were deployed to sample fish passage at each power plant. Transducers (Nominal beam width 6^0), sample fish passage in the forebay in front of the left powerhouse at turbine units G-l, G-3, G-5, G-8, and G-9, at the right power plant, G-10, G-12, G-14, G-17, and G-18 at the third power plant and G-20, G-21, G-22, and G-23. These units were chosen to provide uniform coverage at each power plant with consideration given to turbine maintenance scheduled outages. The transducers were deployed on aluminum carriages attached with steel cables to the trashrack spines at El. 1220 at the left and right power plants and at 1222 at the third power plant. The transducers were aimed down toward the bottom about 10^0 off the face of the trashrack. The relatively large sample volume provided by the 6^0 transducer at the depth of the turbine penstock was beneficial because of the high velocity of the water passing into the turbine intakes. Water velocities are estimated to be between 8 and 10 fps at the turbine penstock intake (Craig Sprankle, USBR, personal communication). In March of 1996, fourteen 420 kHz transducers were placed on 14/24 turbine intakes. Transducers had ranges from 35 meters in depth at the third powerhouse to over 1000 meters at the left and right power plant, a pulse rate of 5 pulses per second was used. The transducers were oriented in a down looking direction. The down looking orientation was necessary to position the wider portion of the beam near the turbine intake to provide adequate detectability. Sensor cables were installed that link each powerhouse to a single multiplexor connected in turn to a computer with a dedicated power supply. Daily monitoring of the transducers is done via telephone modem from Seattle WA.

Single-beam transducers (420kHz) were deployed to sample fish passage at each of three power plants. Transducers (nominal beam width 6 deg.) sampled fish passage in the forebay in front of turbine units G-l, G-3, G-5, G-8 and G-9 at the Left power plant, G-10, G-12, G-14, G-17, and G-18 at the Right power plant and G-20, G-21, G-22, and G-23 at the Third power plant. These units were chosen to provide uniform coverage at each power plant with consideration given to turbine unit maintenance scheduled outages. BioSonics deployed the transducers on aluminum carriages attached with steel cables to the trash racks at elevation 1220 ft. msol at the Left and Right power plants and at elevation 1222 at the Third. The transducers were aimed down toward the bottom about 10 deg. off the face of the trashrack. The relatively large sample volume provided by a 6 deg. transducer at the depth of the turbine penstock intakes was beneficial because of the high velocity of water passing into the turbine intakes. Water velocities are estimated to be between 8 and 10 feet per second at the turbine penstock intakes (Craig Sprankle, USBR, personal communication, 1996). The down looking orientation was necessary to position the wider portion of the beam near the turbine intake to provide adequate detectability. Transducers had ranges from 35 meters at the Third power plant to over 100 meters at the Left and Right, so a pulse rate of 5 pulses per second was used (BioSonics Inc, Annual report, 1997).

Concurrently, with the hydroacoustic survey a gill net survey is conducted on a weekly basis to determine the probable specie composition of fish in the forebay area adjacent to the turbine intakes. Methodologies employed during the species verification part of the project involved the use of gill nets. Experimental gill nets were purchased in both horizontal and vertical orientation. The horizontal gill nets are 80 feet in length and 20 feet in depth. Mesh sizes range from ½ inch to 4 inches 10 foot panels. Horizontal nets are always fished in pairs with mesh sizes in opposition to minimize size selection.

Vertical gill nets are three hundred feet in length and 10 feet wide. A vertical array consists of three nets where the mesh sizes graduate both up and down and from panel to panel. The smallest mesh is ½ in. with the largest being 2 ½ in square measure. Gill nets are deployed by project personnel on a weekly basis for twenty fours each week. No nets are deployed when low lake elevations prevent access, and no hydroacoustic sensing in being carried out. Nets are also not fished during drum gate spill episodes. Fish captured are examined for species, salmonid family specimens are weighed, measured and checked for condition. Natural production kokanee determination is made by presence of an intact adipose fin and lack of a coded wire tag. Dead kokanee of natural production origin are further sampled for genetic analysis. Genetic samples consist of the head, liver and reproductive tissue.

2.4, B Species verification, gill net survey.

Literature review and analysis of reports by Quintin Stober and Anthony Nigro revealed earlier gill net efforts in the forebay of Grand Coulee Dam. Gill net surveys were performed using both vertical and horizontal net sets as described by Stober, 1985, and Nigro, 1883. Surface trawls were also performed with limited success (Maiolie, 1993).

Horizontal and vertical gill nets were constructed and purchased for use during this phase. The horizontal nets are eighty feet in length and twenty feet in depth. Each net is made of eight ten foot wide panels of varying mesh size ranging from 5/8 inch to 2 ½ inches, square measure. Horizontal nets are fished in parallel pairs with mesh sizes in opposition to one another. One net runs from east to west beginning with the larger mesh, the second net is placed parallel to the first beginning with the small mesh.

Horizontal nets are fished at varying depths. One horizontal, gill net is set from the surface to 20 feet, the second net is from 20 feet to 40 feet and the last from 40 feet to 60 feet in depth. A second set of horizontal gill nets are set at the same depths as the other except the meshs run opposite to each other.

The experimental vertical gill nets are twenty feet wide and three hundred feet long. As in the horizontal nets mesh sizes range from 5/8 inch to 2 ½ inches square measure. A vertical gill net array consists of three nets. Each of the three nets contains a different mesh size series ranging from smaller to larger.

The use of vertical nets has not proven very successful for several reasons that include; (1) When vertical nets are placed from the surface to the bottom (300 feet) they tend to tangle up, (2) Migrating fish may sense the net presence due to high forebay water velocities, (3) Juvenile salmonids migrate tail first, this may allow the tail to contact the net and provide the stimulus to move out of the way before being caught, (4) In a system where the dam is nearly an mile long a 20 foot vertical net is like a small string stretched from surface to bottom, (5) Vertical nets pick up debris causing them to drift or collapse, (6) Anchoring vertical nets against the substantial currents present is another problem. Catch rates in the vertical gill nets is very low.

3.0 RESULTS/DISCUSSION

3.1, Adult Spawner Escapement Objective;

The 1997 adult enumeration phase of the project began with the installment of the picket weirs in the San Poil and Nespelem rivers followed by Big Sheep and Barnaby Creeks. Weirs were maintained by project personnel on a daily basis through the fall spawning period, August 13, 1997 - December 1, 1997.

3.1 A San Poil River

The San Poil picket weir was installed on August 23, 1997 near the mouth of the river. The weir has a lockable cover and is maintained on a daily basis. San Poil river adult returns during the 1997 sample season are significantly reduced (Table 1) from the numbers seen during 1996 (Table 2) and 1995 spawning periods. A single male kokanee of hatchery origin was trapped and sacrificed, the head was submitted to Eastern Washington University for CWT analysis.

A variety of fish species were encountered during the trapping period. Many rainbow trout *(Oncorhynchus mykiss)* were enumerated along with a single burbot (*Lota lota*)(Table 1).

Tables were constructed to record date of capture, specie, length, weight origin and sex. A final column was available to record information such as flow, weather conditions and temperature. No table was constructed for 1995 San Poil escapement, an estimate of 70-100 adult kokanee was made.

Fourteen rainbow trout were captured and released from the San Poil weir, because of this number it was felt important to rule out the possible existence of a fall spawning rainbow trout stock in the San Poil basin. A single wild female rainbow trout was sacrificed to determine her spawning status. Based on her egg skein size and development we felt she would have spawned the following spring.

TABLE 1. 1997 ADULT KOKANEE ESCAPEMENT, SAN POIL RIVER.

DATE	SPECIE	LENGTH	WEIGHT	ORIGIN	SEX	COMMENT
8/23	RBT	430 mm	727 g.			19 d C
8/23	RBT	410 mm	707 g			
8/25	RBT	455 mm	743 g			
8/27	RBT	440 mm	1029 G.	W	F	16.5
8/27	RBT	505 mm	1070 g	W	F	
8/27	RBT	470 mm	975 g	W	M	
8/27	RBT	445 mm	936 g	W	M	
8/27	RBT	466 mm	1060 g	W	F	
8/28	RBT	465 mm	897 G	W	M	
8/28	RBT	444 mm	1107 g	W	F	16 D c
8/30	RBT	451 mm	1215 g	W	?	
8/31	RBT	500 mm	1460 g	W	F	
9/02	KOK	425 mm	1052	H	M	TOOK H

9/02	RBT	500 mm	1283	W	F	*
9/27	RBT	475 mm	1160 g	W	F	
9/29	PMM	na				
9/30	BURB	540 mm	NA			

* Fish sacrificed to determine spawning status
** W= Wild or natural origin
*** H= Hatchery Production

TABLE 2. **1996, SUMMARY, KOKANEE SPAWNER ESCAPEMENT,SAN POIL RIVER**

SEX	MALE	FEMALE
NUMBER	6, One sacrificed	4
AVE. LENGTH	341 mm	502
LENGTH RANGE	333 - 345 mm	475 - 535 mm
AVE. WEIGHT	504 g.	1,402 g.
WEIGHT RANGE	479 - 528 g.	1148 - 1748 g.
STATUS	Wild, all	Hatchery, all

3.1 B. Nespelem River

The Nespelem River picket weir was installed on August 18, 1997 and maintained on a daily basis until November 15, 1997. The weir location is the same as in previous years, located 1/4 mile upstream from the Lake Rufus Woods/Nespelem River interface on private property owned by the Davey McClure Ranch. The live box had a lockable door to prevent bird predation and theft. Adult spawner returns in 1997 (Table 4) were lower than 1996 (Table 5) and 1995 (Table 6).

Adult returns to the Nespelem River were down from previous years (Table 5) but greater than in the San Poil (Tables 6 and 7). A single wild female kokanee sample was obtained from the Nespelem River trap operation during 1997 (Table 4). Five other kokanee carcasses were discovered upstream on the pickets indicating the probability that kokanee migrated upstream prior to weir installation.

TABLE 3. 1997 KOKANEE SPAWNER ESCAPEMENT, NESPELEM RIVER

DATE	SPECIE	LENGTH	WEIGHT	ORIGIN	(SEX	COMMENT
8/30	KOK	254 mm	240 g	H	M	DOW
9/01	KOK	?	?	H	F	DOW
9/04	KOK	400 mm	?	H	F	HEAD
9/10	KOK	355 mm	496.5 g	W	F	DOW
9/11	SUC					DOW
9/14	KOK	268 mm	238 g	H	F	DOW
9/14	KOK	293 mm	570g	?	F	DOW

H = Hatchery
** W = Wild
*** DOW = Dead on weir
**** Head = Head removed for cwt analysis

Anecdotal information and local landowner comments indicate kokanee begin returning approximately around Labor day. Water temperatures at the time of installation were considered high at 20 deg. C.(74 deg F). The exposure to these high temperatures may account for the dead kokanee reported. A single Sucker (dead) was also counted this fall. The greatest Kokanee return during fall 1997 was to the Nespelem River (Tables 1,4, 7, and 10).

TABLE 4. 1996, SUMMARY, KOKANEE SPAWNING ESCAPEMENT, NESPELEM RIVER

SEX	MALE	FEMALE
AVERAGE LENGTH	1365.5 mm	475 mm
LENGTH RANGE	340 mm - 391 mm	475 mm
AVERAGE WEIGHT	522 g.	1,080 g.
WEIGHT RANGE	499 g. - 545 g.	1,080 g.
STATUS	Hatchery, all	Wild, all
NUMBER		

TABLE 5. 1995, SUMMARY, KOKANEE SPAWNING ESCAPEMENT, NFSPELEM RIVER

SEX	MALE	FEMALE
AVERAGE LENGTH	492 mm	440 mm
LENGTH RANGE	405 mm - 521 mm	412 mm- 558 mm
AVERAGE WEIGHT	1,347 g.	1.310 g.
WEIGHT RANGE	1005 g. - 1508 g.	1,230 g - 1,390 g.
STATUS	Wild, all	Wild, all
NUMBER		

3.1 C Big Sheep Creek.

The weir at Big Sheep Creek was installed on August 13, 1997 and operated until November 20, 1997. Adult kokanee returns to Big Sheep Creek were non-existent in 1997 (Table 7).

During routine trap maintenance in 1997, at two mountain whitefish and two rainbow trout (Table 7) were enumerated in Big Sheep Creek. The small rainbow trout was found dead on the weir. One of the

Mountain Whitefish had what appeared to a predatory bird peck on its side. Project personnel witnessed a Blue Heron perched on the edge of the live box on several occasions. A locking door was installed to prevent possible bird predation and theft.

TABLE 6. 1995, KOKANEE SPAWNER ESCAPEMENT, BIG SHEEP CREEK

SEX	MALE	FEMALE
AVERAGE LENGTH	510 mm	486 mm
LENGTH RANGE	510 mm	477 mm - 495 mm
AVERAGE WEIGHT	?	1,437 g.
WEIGHT RANGE	?	1,390 g. - 1,485 g.
STATUS	HATCHERY	WILD
NUMBER		

TABLE 7. 1997, KOKANEE SPAWNER ESCAPEMENT, BIG SHEEP CREEK

DATE	SPECIE	LENGTH	WEIGHT	ORIGIN	SEX	COMMENT
9/06	MWF	282 m/m	?	w	?	
9/07	RBT	356 m/m				
9/12	MWF	release				
9/21	RBT	68 m/m				

Unusual heavy fall rain storm events caused very high water levels during the fall of 1997. The high flow events combined with the accompanying heavy leaf fall build up on the weir caused them to tip over. High flows also scoured the substrate that supported the trap and picket panels. The constant effort to keep the Sheep Creek weir in operation and minimize down periods required that the trap be moved to a more secure location approximately 75 ft. upstream. The periods when the weir was breached may account for the lack of enumerated adult kokanee.

In 1996, no kokanee were seen at Big Sheep creek, therefore no table was constructed.

3.1 D Barnaby Creek

A picket fence type of weir was installed in Barnaby Creek on August 18, 1997 and operated until mid-October 1997. No wild origin kokanee returned to Barnaby Creek during 1997 (Table 10).

At the Barnaby Creek site, a pair of hatchery males were released on the downstream side of the weir. A single rainbow trout and a Brown Bullhead were also counted at the site. The carcass of the Brown Bullhead was recovered from the up-stream side of the weir pickets the rainbow trout was released upstream.

TABLE 8. 1997, KOKANEE SPAWNER ESCAPEMENT, BARNABY CREEK

DATE	SPECIE	LENGTH	WEIGHT	ORIGIN	SEX	COM.
?	BBH	*228.6*	*?*			DOW
9/16	KOK	*219* m/m	*368* g.	H	?	REL
9/16	RBT	297 m/m	?	W	?	REL
10/01	KOK	298 m/m	?	H	M	REL

The number of Kokanee encountered at Barnaby Creek was very low considering several thousand Kokanee were planted near the reservation border two years prior. Both of the captured hatchery origin, male, kokanee were released downstream of the weir as was the wild rainbow trout.

Fish returns to Barnaby Creek are hampered by the culvert under the Inchelium highway during periods of lake drawdown. When Lake Roosevelt levels drop below 1,280 ft. more so or less (msol), access is prevented. Water levels below the 1280 ft. level were recorded several times during the trapping period. The improperly installed culvert causes high culvert gradients and high velocities that returning fish may not be able to overcome.

The trap is located within fifty yards of the Lake Roosevelt/Barnaby Creek interface. It is situated below a very steep bank with heavy forest canopy that renders any form of predation difficult.

TABLE 9, 1997, SUMMARY, KOKANEE SPAWNING ESCAPEMENT ALL STREAMS.

LOCATION	KOKANEE	OTHER	ORIGIN	SEX	COMMENTS
San Poil	1	16	H	M	S
Nespelem	6	1	W	1-H male	
Big Sheep	0	4	W		
Barnaby	2	2	H	M	R
Total Returning Kokanee			9		

* H = Hatchery
** W = Wild or natural
*** S = Sampled head
**** R = Released downstream

All project streams had dismal returns. The cause of this is unknown at this time, but may be a function of entrainment, fishing pressure, lake operations or flood events. Spring flood periods scoured out large reaches of spawning substrate, potentially this may have wiped out an entire age class.

Potential contribution to the kokanee fishery of Lake Roosevelt from the 1997 spawning cohort is unknown in monitored streams.

3.2 EGG TO FRY SURVIVAL OBJECTIVE

During 1997 egg to fry studies were limited to out-migration enumeration conducted using a 5 ft. E. G. Solution Rotary Screw Trap. This method has been used successfully by many fisheries studies (Hanson 1995. 1996)

Initially, the trap was deployed in the San Poil river on March 16, 1997 at the same location as in the previous year. The location is on private property owned George Peabody and family. The site was chosen for it's thalweg features and site security.

The trap was operated on an intermittent basis due to high water flows. During the night of April 21, 1997, a flood event destroyed the trap site. This event greatly altered the site making its future use questionable. Alterations include, new gravel deposition and the removal of the bank containing the large (30 inch) Ponderosa pine that the trap was anchored too. The trap was carried away and totally destroyed. The missing/destroyed trap was located one mile downstream from its prior location. The trap is in several pieces, with the drum in one place and the pontoons another. We will retrieve as much as possible when Lake Roosevelt is drawn down. We were able to salvage the pontoons but are un-able to recover the drum or the holding tank at this time.

After consultation with the project C.O.T.R. at the Bonneville Power Administration a verbal ok was given to proceed with a budget modification to purchase a new trap from the manufacturer E. G. Solutions in Corvalis, Oregon.

Following clean up efforts by the project crew the at the site. The new trap was re-deployed 60 ft. downstream from the old site. The new trap was installed on the ninth and tenth of June and will be operated around the clock until summer low flows require its removal. Upon removal and disassembly it was disinfected and returned to the Colville Tribal Hatchery for storage.

During the course of the two deployment periods a total of 1,788 juvenile fish were captured, processed and released (Table 13).

Biological data was recorded from juvenile salmonid species that include length, weight and condition. Non-salmonid species were recorded by species, enumerated and released without further data collected. Salmonid species totaled 384 fish. The 384 fish total was made up of a single Kokanee (Oncorhynchus nerka) and 383 rainbow trout (Oncorhynchus mykiss) (Table 10). Salmonids made up 21 percent of the total catch (Table 10).

Non-salmonid species totaled 1,404 fish or 78 percent of the total. Of the total 1,065 of the fish *were* sucker species *(Catostomidae)* or 75 percent of the total catch. The balance of the non-salmonid total include 123 northern pike minnow *(Ptychocheilus oregonensis)*, 121 dace species *(Rhinichthydae)*, 70 red side shiner *(Richardsonius balteatus)*, 23 sculpin species *(Cottidae)* and two burbot *(Lota lota)*.

TABLE 10. 1997, SAN POIL RIVER SCREW TRAP SUMMARY.

SPEC.	KOK	RBT	SUC	BMM	SCUL	DACE	SHIN	BUR
TOTAL	1	383	1065	123	23	121	70	2
TOTAL SALMONID			384			21%		
TOTAL NON-SALMONID			1404			78%		
Grand Total Outmigrants				1,788				

Legend Kok = Kokanee

RBT = Rainbow Trout (Oncorhynchus mykiss)

SUC = Sucker species

BMM = Northern Pike Minnow

SCUL = Sculpin species

Dace = Dace species

Shin = Red Side Shiner (Richardsonius balteatus)

Bur = Burbot (Lota lota)

During the final weeks of 1997 trap deployment the number of rainbow trout continually increased as a percent of the catch. It was decided that a trap efficiency study may provide information on total out migration. A trap efficiency study was undertaken using Seber Lecren mark-recapture methodology. Captured rainbow trout juveniles were held in a live well 1/4 mile up-stream from the trap site and held until a group of 10 to 15 were in captivity. They were anesthetized using a 66 ppm solution of MS-222 (Methane Tricaine Sulfonate). After anesthetizing, the adipose fin was clipped. The fish were then allowed to recover in fresh water before being placed in a live box for holding. The clipped fish were held 24 hours to observe any mortality prior to release back into the San Poil River. Because of the close proximity of the screw trap to the holding pen, this test was repeated approximately every other day for a total of four trap efficiency studies. Trap efficiency ranged from four (4) to twenty six (26) percent with the average at 13.25 percent (Table 14).

TABLE 11; 1997, SCREW TRAP EFFICIENCY STUDY.

TEST	6/26	7/01	7/03	7/18
RELEASED	15	38	24	23
RECAPTURE	4	4	1	3
PERCENT	26%	10%	4%	13%
AVERAGE EFFICIENCY		113.25 %		

Calculations indicate that based on the average efficiency, a total of 2,890 rainbow trout could have potentially migrated out of the San Poil River into Lake Roosevelt. The same calculation was done for kokanee salmon, this resulted in a possible 8 kokanee out-migrating into Lake Roosevelt.

The following formula was used:

Expanded Number of Fish = T

Average efficiency in percent = E

Number of fish sampled = S

T= S/E X 100% Example: 383 RBT\13.25 X 100% = 28.9 X 100% equals an expanded total of 2,890 rainbow trout out-migrants (Table 15).

TABLE 12; 1997, EXPANDED OUT-MIGRATION

TOTAL OUT-MIGRATING RBT	2,890
TOTAL OUT-MIGRATING KOK	7.54
TOTAL SALMONID	2,989

The expanded number of outmigrant fish was calculated from time sampled and not un sampled periods. Due to manpower constraints, sampling did not occur 24 hours per day as in the past.

3.3 GENETIC DETERMINATION OBJECTIVE;

Genetic samples submitted during 1997 were comprised of fish obtained during gill net operations and were limited to wild origin fish. All fish samples were processed using protocols received from the University of Montana (Leary 1995). The sample was composed of the fish head, liver and a small gonadal tissue sample. The gonad sample was either a few eggs or a ½ inch cut of male gonad. Following sample acquisition, the samples were immediately frozen in a chest freezer and kept until shipment to the University of

Montana for analysis. The frozen fish samples were packed into pre-manufactured Styrofoam shipping containers containing a five pound block of dry ice and shipped via Fed. Ex. overnight.

Genetic analysis work during fiscal 1997 was limited to a total of 32 samples sent to the University of Montana in Missoula for electrophoretic analysis. All of the 32 samples sent were obtained during the gill net portion of the project.

Adult returns were limited in number resulting in no carcass recovery in 1996. No adult kokanee returned to Big Sheep Creek therefore no carcasses were obtained for analysis. Two kokanee pairs returned to the San Poil River during 1996 and one pair in 1997 (Table 6) *No* biological samples were obtained for genetic analysis. *No* samples were obtained from the Nespelem River as well.

A total of 32 tissue samples were obtained from Kokanee caught in the Gill Net portion of the hydroacoustic study. Subsequent data analysis of these 32 samples revealed that 4 samples were rainbow trout not kokanee. Genetic analysis of these 4 fish was not conducted beyond the point that they were determined not to be kokanee. The samples were mis identified in the field. The results of the analysis may be seen in Attachment A.

Tissue samples obtained from kokanee carcasses during the fall 1995 spawning run were analyzed at the University of Montana under contract with Dr. Robb Leary. The standard starch gel plate battery was performed that revealed that the current San Poil/Nespelem stock was likely a stock not related to Lake Whatcom, Okanogan or Wenatchee river stocks. In fact, it may be a genetically unique stock. The results of the genetic analysis from samples obtained during the fall 1995 period, are found in Attachment A.

The standard electrophoretic starch-gel plate process was applied to the samples of kokanee tissue obtained from the fore-bay of Grand Coulee Dam as part of the Gill Net survey. Genetic analysis reveals that the samples obtained from the Gill Net survey are different but similar to the stocks found in the San Poil/Nespelem Rivers.

For purposes of simplicity, we have assumed that any kokanee caught in the forebay of Grand Coulee Dam with an intact adipose fin is of natural production origin. Potentially these natural production fish may be from one of more sources including natural production within the boundaries of Lake Roosevelt, Lake Roosevelt tributaries, Spokane River, Pend Oreille river, the Upper Columbia, Arrow Lakes, or the Kootenai Lake system.

Comparisons between the current San Poil/Nespelem and other stocks such as Okanogan River, Lake Whatcom and Lake Wenatchee as well as other well known stocks such as Kootenai and Flathead lakes reveal no relationship (See attachment A). It is evident from the genetic analysis that the current San Poil/Nespelem river stock is more closely related to the forebay stocks than to any other stocks (Attachment A). Kokanee enumerated during routine creel efforts may originate in upstream reservoirs and lakes including the Lake Coeur d'Alene and Spokane River system, Lake Pend Oreille and Pend Oreille River system and the Kootenay River/Lake system. Genetic analysis conducted in 1996 on samples from San Poil/Nespelem 1995 spawn return indicate no relationship to the North Arm, West Arm and Central portion of Kootenay Lake, British Columbia.

Further genetic analysis is necessary before any concrete conclusions may be made.

Subsequent analysis of forebay samples indicate that this kokanee stock is similar to the San Poil/Nespelem river stock but are different. All other samples (literature values) form a genetically similar group. The 1997 conclusion is that there is a large amount of genetic divergence between the two groups (Attachment A).

3.4 A DAM ENTRAINMENT OBJECTIVE.

Hydroacoustic sensing of entrained fish numbers through the turbine units at Grand Coulee Dam has continued nearly un interrupted since March of 1996. The exception was in 1996 and 1997 when flood control operations dropped the level of the lake to 1,208 ft. msol (BioSonics Inc.), BioSonics, the hydroacoustic contractor is monitoring the same turbine units as during 1996. These units include, on the Left Powerhouse, Unit 1, Unit 3, Unit 5, Unit 7 and

Unit 8 of the Left powerhouse. Units 10, 12, 14, 17 and 19 on the Right powerhouse and Unit 20, Unit 21, Unit 22 and Unit 23 on the Third powerhouse.

Single beam hydroacoustic sensing is limited in the detection of size classes because of the inherent variability of target acquisition. For the most part, the reflected sonar beam bounces off the fish swim bladder, the scales also act as reflectors. The contractor, BioSonics Inc., of Seattle, installed three single-beam fixed-location acoustic systems for this study, a separate system for each power plant. A fixed location technique was used in that the transducer mount locations are constant, as opposed to mobile acoustic surveys. These techniques were similar to those used at Wells Dam (Kudera et. al. 1992) and are explained by Thorne and Johnson (1992). The following methods are described in detail in Appendix A (1996, BioSonics Annual Report): (1) operating the BioSonics acoustic system; (2) data analysis. Specifics pertaining to the operation of the system are described below. A limited number of problems were encountered during the sensing period. Unit 23 of the third powerhouse was shut down for maintenance in July. An attempt to move the transducer to unit 24 proved futile. Unit 23, which had the greatest entrainment in 1996 is scheduled to re-start in late December of 1997. Severed transducer cables on the left and right powerhouses were another problem. The cables were cut by logs and debris that became lodged against the intakes during the annual drawdown. Data gaps exist as a result of un monitored intakes. The following data was collected and analyzed on a powerhouse by powerhouse basis, the discussion follows the same progression.

LEFT POWERHOUSE,

Seasonal Distribution;

During the 1997 study year, seasonal distribution or run timing was very similar to 1996. Fish abundance figures peaked during the May/June period. A small peak occurred in December of 1997. Smaller peaks were documented from March to May and a larger small peak occurred during December of 1997.

Diel Distribution;

During 1997, no constant diel trend occurred as it did during 1996. Summer daytime abundance were generally higher during 1997. Crepuscular period changes occurred during the months of January, November and December.

Horizontal Distribution:

Data analysis revealed no consistent horizontal trends during 1997. Numbers of entrained fish during the daytime hours were higher in April, May, June, July, and August at all five transducer locations. Passage rates were low until peaks of 2-3 fish per hour occurred during May and June.

Vertical Distribution,

In general, fish were concentrated within 20 meters of the transducers. Actual depths vary due to fluctuating lake levels. During January 1997, fish were concentrated near the surface. Concentrations shifted to deeper strata in the following months. Distributions during April, May and June were more surface oriented, differences in day and night were slim. Fish utilizing surface areas may be prone to entrainment through spill episodes. Water may be spilled for flood control or light show purposes.

RIGHT POWERHOUSE

Seasonal Distribution,

Seasonal distribution trends were similar to those seen in 1996 at the right powerhouse. Distribution trends were also similar to the Left powerhouse. A peak in abundance was seen in May/June for both 1996 and 1997 at both the left and right powerhouses. Another peak occurred during September of 1997.

Diel Distribution,

In 1997, at the right powerhouse, diel distribution was very similar to that seen at the Left powerhouse. Overall abundances seen were similar as well.

Horizontal Distribution,

Horizontal distribution of fish targets is the key to fish entrainment. Monthly entrainment reports include both "all" fish targets and an entrained fish target chart. At the left and right powerhouses, entrained fish are those targets counted within an elevation range of 59 feet. The centerline of these penstocks is at elevation 1041 ft.. Fish targets sampled within the acoustic beam within these elevational constraints were labeled entrained. The assumption is that fish this close to the penstock opening are entrained because of the high velocity flows (8-10 fps).

Vertical distribution,

Vertical distributions at the right powerhouse were similar to those at the left powerhouse in that fish were generally concentrated in the strata within 20 meters of the transducer. During January and February, fish were more surface oriented with few fish at intake depths. Vertical distributions deepened from July through October. As at the left powerhouse strong diel differences were seen. During the night time periods of November and December 70% of the fish were seen within 20 meters of the transducer.

THIRD POWERHOUSE,

Seasonal Distribution

The seasonal distribution peak occurred in June of 1997 for both day and night periods. This is similar to 1996 but the length of the peak was reduced to two months from the previous four month period in 1996.

Diel Distribution,

In general fish abundance at the third powerhouse was similar during the day period and night periods. Daytime values are higher during August and September. No diel trends were seen during other months of the sample period,

Horizontal Distribution,

The highest entrainment during 1996 and 1997 occurred at the third powerhouse with unit G-23 entraining more fish that all others. This may be a function of the shallower intakes (100 ft.) than the left of right or a function of the location of unit G-23 in the power plant cald-e-sack. Fish abundance exceeded 100 fish per hour during May and June. As expected, entrainment was high as well for these two months.

Vertical Distribution,

At the third powerhouse, 1996 and 1997 vertical distributions were similar during the early months of the year. In March they began to be oriented near intake depths with high abundances. During September, distribution deepened becoming more uniform with 40% of the targets within range of the turbine intakes.

Acoustic Size Distribution,

Acoustic size (Target strength) distributions were similar showing a single mode. Only data from the month of June was analyzed because of the high fish abundances present. Data interpretation indicates that the largest average target strength of -44 dB is representative of a fish in the 175 mm range. This target strength/size is associated with the left powerhouse. The smallest target strength, -49 dB or a fish target 125 mm in size is associated with the right powerhouse. In between is a target strength of **-46** dB, this corresponds to a size of 150 mm and is associated with the third powerhouse.

Entrainment totals calculated at the third power house during 1997 are much lower than in 1996.

Entrained fish numbers were calculated using a Grile table of day and night lengths (Table 10) in Pacific Standard Time (PST) for each month sampled. The Grile table is corrected for longitude and is based on sunrise and sunset at Spokane Wa. (U. S. Grile Research co. 1977).

TABLE 13; GRILE TABLE OF DAY VS NIGHT LENGTHS

MONTH	DAY TIME	NIGHT TIME	D. LENGTH	N. LENGTH
JANUARY	0700-1559	1600-0659	9 HR.	15 HR.
FEBRUARY	0700.1659	1700-0659	10 HR.	14 HR.
MARCH	0600-1759	1800-0559	12 HR.	12 HR.
APRIL	0500-1759	1800-0459	13 HR	11 HR
MAY	0400-1859	1900-0359	15 HR.	9 HR.

JUNE	0400-1959	2000-0359	16 HR.	8 HR.
JULY	0400-1859	1900-0359	15 HR.	9 HR.
AUGUST	0500-1759	1800-0459	13 HR.	11 HR.
SEPTEMBER	0500-1759	1800-0459	13 HR.	11 HR.
OCTOBER	0600-1659	1700-0559	11 HR.	13 HR.
NOVEMBER	0700-1559	1600-0659	9 HR	15 HR.
DECEMBER	0700-1559	1600-0659	9 HR.	15 HR.

Data analysis does not reveal entrainment numbers from the ten un-monitored turbine units. At left powerhouse located on the east side of Lake Roosevelt, turbine units G-2, G-4, G-6 and G-7 are not monitored. At the right powerhouse located in mid lake, turbine units G-11, G-13, G-15 and G-16 are not monitored. At the third powerhouse located on the Colville Indian Reservation side of the reservoir, turbine units G-19 and G-24 are also monitored. Proceeding from left to right, Unit G-19 is the first turbine of the third powerhouse and G-24 is the last. Data analysis reveals that entrainment increases from the left powerhouse, to the right, then to the third powerhouse. The third powerhouse is constructed in a cald-e-sac. Monitoring of unit G-23, located deep inside the cald-e-sac, reveals the highest entrainment rate of any other turbine.

Entrainment through un-monitored turbines is unknown at this time, but may be considerable (Colleen Sullivan, personal communication)

Unit outages,

At the left powerhouse, in January of 1997 units G-8 and G-9 were down for most of the month. Unit G-2 was down from April of 1997 until Nov 1, 1997 and operated 71% of the time for the duration of the year. Average annual operating time for all left powerhouse turbines averaged 59% (Table 20).

At the right powerhouse, a single unit (G-10) was down for one month period during November. Average annual operating times for all right powerhouse turbines was 72% (Table 20).

The third powerhouse, constructed during the early 1970's, was built solely as a power peaking facility. This is evidenced by the large turbine penstock intakes of 40 feet compared to the left and right turbine intake diameter of 18 feet (BOR 1972). In addition the third powerhouse turbine intakes are much shallower (one hundred feet) than those located at the left and right powerhouses. The centerline for the eighteen foot left and right turbine intakes is at ele. 1,041, while the centerline of the third powerhouses 40 foot turbine is 1,141. a full 100 feet shallower.

Many outages occurred at the third powerhouse, unit G-21 was shut down for maintenance from mid March, 1997, until Mid-August 1997. Unit G-21 was operated at an average 60% of the time for the year (Table 19) Unit G-22 was operated 95% of the time during 1997 (Table 19).

TABLE 14, 1997, ENTRAINED FISH BY TURBINE, LEFT POWERHOUSE.

MONTH	G-l	G-3	G-5	G-8	G-9	DAY	NIGHT	TOTAL
JAN D	53	38	144	75	39	349		
N	159	184	242	91	120		796	1,145
FEB D	30	31	13	0	0	74		

N	48	36	59	0	14		157	231
MAR D	28	76	88	21	73	286		
N	37	39	3	25	24		128	414
APR D	0	52	363	196	338	949		
N	0	53	68	25	48		194	1143
MAY D	0	809	1160	411	1719	4099		
N	0	573	492	128	481		1674	5773
JUN D	0	1010	1130	512	1247	3899		
N	0	268	327	119	417		1131	5032
JUL D	0	402	485	54	290	1231		
N	0	115	65	45	144		369	1600
AUG D	0	144	235	138	235	752		
N	0	129	66	47	11		253	1005
SEP D	0	108	267	143	235	753		
N	0	293	365	340	303		1301	2054
OCT D	0	102	102	142	49	395		
N	0	82	71	45	104		302	697
NOV D	33	22	37	50	55	197		
N	55	91	61	82	192		481	678
DEC D	34	55	24	47	57	217		
N	95	117	58	148	134		552	769
TOT D	178	2688	3683	1618	4226			10775
TOT N	394	2086	1993	1160	2140			6613
G. TOT	572	4774	5676	2778	636			
TOTAL DAY			ALL TURBINES			13,383		
TOTAL NIGHT			ALL TURBINES			7,377		
1997 TOTAL ENTRAINMENT LEFT PH				20,760				

During 1996 this unit was responsible for a high degree of entrainment. Unit G-23, where the highest entrainment occurred during 1996, was down from mid-July 1997 until January of 1998. During 1996, turbine intake G-23 was responsible for more than half of the total annual entrainment during the July day period. The lower 1997 entrainment total is probably caused by no data collection at G-23 during down periods.

In April of 1997, unit G-22 was disabled and the data collected is lower than expected. The transducer unit was re-aimed and repaired and brought back on line July first. G-22 was operated 95% of the time during the year. We assume that while G-22 and G-23 were down unit G-24 came on line and aided in the powerpeaking effort. Turbine unit time on line analysis reveals that at the third powerhouse G-19 was operated 91 % of the year (Table 23). Units G-19, G-20, G-21, G-22 and G-23 operated at a 97%, 60%, 95%, 59% and 92% of the times respectfully (Table 24).

TABLE 15; 1997, ENTRAINED FISH BY TURBINE, RIGHT POWERHOUSE.

MONTH	G-10	G-l.2	G-14	G-17	G-18	DAY	NIGHT	TOT
JAND	21	55	25	78	110	289		

N	27	120	89	163	259		657	946
FEB D	5	70	17	26	52	170		
N	18	30	24	19	17		108	278
MAR D	14	246	143	17	32	451		
N	12	130	18	42	25		227	678
APR D	67	0	0	0	45	112		
N	51	0	22	23	20		116	228
MAY D	136	282	594	225	332	1569		
N	219	287	434	267	431		1547	3116
JUN D	284	928	917	547	605	3509		
N	210	150	452	294	305		1411	4920
JULD	101	250	243	162	424	1180		
N	22	263	320	222	170		997	2177
AUG D	217	715	438	355	229	1954		
N	193	287	66	141	80		767	2721
SEP D	72	127	149	142	162	654		
N	15	451	272	341	302		1381	2035
OCT D	23	264	336	323	212	1158		
N	10	206	110	110	111		547	1705
NOV D	0	98	136	182	80	496		
N	0	62	78	46	61		247	743
DEC D	43	110	235	197	325	910		
N	40	131	171	144	135		664	1574
T.Day	941	3044	3140	2257	2693			12075
T.NIT	880	2183	2128	1913	2017			9121
G.TOT	1821	5221	5268	4170	4710			21096

TOTAL DAY	ALL TURBINES	112,075
TOTAL NIGHT	ALL TURBINES	9,121

GRAND TOTAL FOR POWERHOUSE	21,196

TABLE 16; 1997, ENTRAINED FISH BY TURBINE, THIRD POWER-HOUSE,

MON	G-20	G-21	G-22	G-23		TOT D	TOT N	M TOT
JAN D	714	421	709	2165		4009		
N	1646	1218	1893	2585			7342	11351
FEB D	413	508	338	465		1724		
N	416	659	529	792			2396	4120
MAR D	4241	0	4181	2176		10598		
N	2861	0	1941	2172			6974	17572
APR D	1443	0	1599	2059		5101		
N	1696	0	1076	1901			4673	9774
MAY D	45930	0	69*	17933		63932		
N	26927	0	0	14463			41389	10532
JUN D	25761	0	0	32861		58622		
N	9151	0	0	14302			23453	82075
JUL D	6124	0	1646	8937		16707		
N	3753	0	1894	4832			10479	27186
AUG D	1729	846	3067	0		5642		
N	979	682	1739	0			3400	9042
SEP D	796	507	1587	0		2890		
N	723	726	792	0			2241	5131
OCT D	1149	215	396	0		1760		
N	1439	363	729	0			2531	4291
NOV D	594	230	297	0		1121		
N	1143	257	198	0			1598	2719
DEC D	432	338	322	0		1092		
N	1092	874	845	0			2811	3903
TOT D	86033	3926	13631	58820				

TOT N	56584	4899	12504	46287				
G TOT	142617	7925	26137	105107				
TOTAL DAY		ALL TURBINES			162,615			
TOTAL NIGHT		ALL TURBINES			118,362			
GRAND TOTAL FOR POWERHOUSE				280,977				

Table **17,** **ENTRAINMENT** LOSSES, 1996 VS 1997.

MONTH	**YEAR**	**LEFT**	**RIGHT**	**THIRD**	**TOTAL**
JANUARY	1996	0	0	0	0
	1997	1,145	947	1,349	13,441
FEBRUARY	1996	0	0	0	0
	1997	655	576	4,324	5,555
MARCH	1996	142	387	3,763	4,292
	1997	319	692	13,232	14,243
APRIL	1996	674	14,119	11,999	26,792
	1997	1,141	221	9,829	11,191
MAY	1996	1,205	2,217	67,286	70,708
	1997	5,841	3,073	105,746	114,660
JUNE	1996	1,498	2,242	64,999	68,739
	1997	5,028	4,915	82,082	92,025
JULY	1996	1,200	4,044	412,687	417,931
	1997	1,417	4,915	82,028	88,360
AUGUST	1996	688	1,071	122,790	124,549
	1997	1,005	2,721	7,512	11,238
SEPT.	1996	867	791	50,250	51,908
	1997	2,053	1,925	3,956	7,034
OCT	1996	505	585	29,942	31,032
	1997	571	630	27,956	28,883
NOV.	1996	822	361	10,726	11,909

	1997	363	423	13,236	14,634
DEC.	1996	515	838	7,259	8,612
	1997	713	803	6,990	8,506
TOTAL	1996	8,116	26,655	781,701	816,472
	1997	20,760	21,196	280,977	322,933

TABLE 18; 1997, LEFT POWERHOUSE OPERATION, PERCENT TURBINE ON.

MON	G-1	G-2	G-3	G-4	G-5	G-6	G-7	G-8	G-9
JAN	81.7	59.3	97.9	86.9	98.7	85.7	75.5	79.9	75.4
FEB	99.3	0.00	92.5	77.9	100	77.3	82.6	80.6	80.6
MAR	87.4	0.00	85.5	73.1	93.6	84.8	73.9	74.0	71.6
APR	99.6	53.3	97.9	98.1	97.4	95.4	88.1	88.4	75.8
MAY	98.9	99.9	99.6	99.4	99.7	99.8	99.8	99.8	58.0
JUNE	99.7	99.2	99.4	100	100	99.4	99.9	99.9	56.6
JULY	99.4	98.2	93.9	97.6	91.1	99.8	99.8	87.6	97.7
AUG	99.7	98.9	99.8	88.8	83.1	91.4	78.8	83.2	85.3
SEPT	88.3	88.0	73.9	26.8	62.0	64.0	63.8	70.6	47.8
OCT	77.5	74.5	88.0	0.00	78.2	90.3	58.6	75.0	79.6
NOV	78.9	88.8	80.0	0.00	61.0	81.6	50.6	52.6	65.8
DEC	94.0	94.3	83.7	0.00	97.3	83.4	78.7	77.4	77.5
AVE	92.1	71.2	91.0	62.3	88.5	87.8	79.0	80.4	72.

TABLE 19; **1997,** RIGHT POWERHOUSE OPERATIONS, PERCENT TURBINE ON.

MON	G-10	G-11	G-12	G-13	G-14	G-15	G-16	G-17	G-18
JAN	79.2	48.4	84.5	80.6	79.2	91.1	18.8	38.0	76.7
FEB	76.4	78.4	90.2	100	77.0	96.3	0.00	69.4	69.4
MAR	91.7	77.1	94.1	87.7	90.8	90.7	0.00	85.9	73.1

APR	99.5	94.1	99.9	99.9	99.9	99.8	0.00	82.0	99.7
MAY	100	100	96.4	99.1	100	100	0.00	100	100
JUNE	98.9	98.9	98.9	98.9	99.8	100	0.00	100	100
JULY	95.0	99.9	99.9	99.9	95.9	95.6	0.00	95.9	93.9
AUG	94.1	86.8	87.1	99.6	86.0	88.7	0.00	91.7	89.3
SEPT	85.0	82.5	93.4	82.0	78,4	89.5	0.00	71.9	86.8
OCT	73.8	74.1	87,9	75.1	73.0	81.1	1.12	60.2	51.0
NOV	69.6	80.1	72.4	75.0	89.6	86.0	79.4	79.8	76.2
DEC	95.5	89.8	0.00	98.1	83.5	98.9	98.7	96.9	97.5
AVE	88.2	84.1	83.7	91.3	86.7	93.0	16.5	81.0	84.5
Average annual operation					59%				

TABLE 20; 1997, THIRD POWERHOUSE OPERATIONS, PERCENT TURBINE ON.

MONTH	**G-19**	**G-20**	**G-21**	**G-22**	**G-23**	**G-24**
JAN	**96.5**	**100**	**99.9**	**77.6**	**99.6**	**99.7**
FEB	96.2	99.9	80.4	100	92.6	99.4
MAR	80.4	98.2	0.00	99.2	97.1	98.1
APRIL	99	97.8	0.00	95.5	98.0	93.0
MAY	100	100	0.00	100	100	99.0
JUNE	100	00	0.00	99.7	98.0	76.7
JULY	99.5	99.9	0.00	74.3	95.3	83.0
AUG	94.4	91.3	86.0	99.7	0.00	99.9
SEPT	99.9	80.4	99.0	100	0.00	70.1
OCT	90.8	99.0	96.8	100	0.00	86.8
NOV	80.8	100	98.36	99.7	0.00	99.8
DEC	100	98.1	96.8	99.0	28.4	98.0
AVERAGE	94.8	97.0	60.0	95.0	59.0	91.9

Table 21, 1997, Average Powerhouse Operation.

Powerhouse	Left	Right	Third	Average
	72.0	59.0	91.9	74

3.4 B Species Identification

Specie composition during 1997 was very similar to 1996 (Table 22). More kokanee were caught during 1997 than in 1996. This is due in part to the increased sample time, nine months in 1996 vs 12 months in 1997. Generally, the yearly catch progression matches that of the previous year. Incidently, an excellent kokanee fishery exists near the third powerhouse that has been documented during winter and spring months over several years.

The "other" category was higher in 1996 because we did not lump species together in 1997.

TABLE 22, SPECIE ABBREVIATIONS

KOK	KOKANEE
RBT	RAINBOW TROUT
WAL	WALLEYE
SMB	SMALL MOUTH BASS
SUC	SUCKER FAMILY
CAR	CARP
BUR	BURBOT
LWF	LAKE SUPERIOR WHITEFISH
PER	PERCH
OTH	OTHER

TABLE 23; 1997, GILL NET CATCH, SPECIES COMPOSITION.

MON	KOK	RBT	WAL	SMB	SUC	CARP	BURB	LWF	PER	OTH
JAN	22	10	4	0	1	0	2	1	0	0
FEB	0	3	0	0	0	0	0	0	0	0
MAR	2	0	1	0	0	0	2	0	0	0
APR	1	1	0	0	0	0	0	0	1	0
MAY*										
JUN	1	0	0	0	0	0	0	1	0	0
JUL	1	1	0	0	0	0	0	2	0	0
AUG	0	4	4	17	3	2	0	0	0	0
SEP	2	2	11	16	2	0	2	0	0	0
OCT	0	0	1	4	1	0	0	5	0	0
NOV	0	0	1	0	0	0	0	8	0	0
DEC	0	0	0			0	0	0	0	0
TOTAL	29	21	22	37	7	2	6	17	1	**141**

* Nets were not fished during the month of May.

TABLE 24; 1996, GILL NET CATCH, SPECIES COMPOSITION

MONTH			SPECIES AND TOTAL			
	KOK	RBT	WALL	SMB	LWF	OTHER
AUGUST	0	2	8	21	0	4
SEPT.	1	4	3	8	0	6
OCT.	5	6	8	5	0	8
NOV	0	0	2	0	0	0
DEC	5	3	0	0	1	0
TOT C.	11	15	21	34	1	24
TOTAL GILL NET CATCH			106			

TABLE 25, 1996 VS 1997 PERCENT OF CATCH BY SPECIE

	KOK	RBT	WAL	SMB	SUC	CAR	BUR	LWF	PER	OTH	
96	10%	14%	19%	32%				<1%		22%	
97	20%	14%	15%	26%	04%	1%	4%	12%	1%	1%	

During the 1997 gill net sampling phase of the project, a total of 29 kokanee (Table 26) were collected. Of the gill net kokanee catch, 24 fish or 83 percent were of natural production origin. Five kokanee or 17 percent were of hatchery origin (as evidenced by the lack of an intact adipose fin). Kokanee made up 20 percent of the total annual catch (Table 28).

TABLE 26; 1997 KOKANEE CATCH BY MONTH, SEX AND ORIGIN.

Month **Origin** **Sex**

MONTH	HATCHERY	WILD	MALE	FEMALE	TOTAL
January	3	19	11	11	22
February	1	0	0	1	1
March	0	1	0	1	1
April	0	1	0	1	1
May *					0
June	0	1	0	1	1
July	0	0	0	0	0
August	0	0	0	0	0
September	1	1	1	1	2
October	0	1	0	1	1
November	0	0	0	0	0
December	0	0	0	0	0
TOTAL					
ANNUAL GRAND TOTAL KOKANEE			29		

* Nets not fished during month.

4.0 CONCLUSION and RECOMMENDATIONS

4.1 Spawner Escapement.

Spawner escapement during 1997 was much lower in all tributaries except for the Nespelem River. The reasons for the substantial decline are not fully understood at this time. Habitat conditions, temperatures, lake elevations, flow regimes and fishing pressure are all probable causes. Further enumeration studies are warranted and necessary to detect further declines.

4.2 Egg to Fry Survival.

During 1997, egg to fry survival studies counted a single juvenile kokanee out migrating from the San Poil River. I suspect that this number is a function of the low spawning escapement seen during fall 1996.

Outmigrating rainbow trout were counted in large numbers during the spring period monitored by the rotary screw trap. Additionally, substantial numbers of juvenile forage fish were enumerated that include suckers, dace, and sculpins.

The collected data was shared with the Lake Roosevelt Rainbow Trout Habitat/Passage Improvement project, Spokane Tribe of Indians, Eastern Washington University, fisheries research center and the Washington Department of Fish and Wildlife. Information pertaining to all four objectives was summarized and presented to the WDFW as required by conditions of the 1997 scientific collection permit. Continued operation of the rotary screw trap is strongly recommended.

4.3 Genetic Determination.

Genetic analysis results submitted by Dr. Rob Leary at the Wild Salmon and Trout Genetic lab in Missoula Mt. indicate the existence of a potentially unique stock of kokanee in the San Poil and Nespelem Rivers (Attachment A). Based on this finding, further genetic studies are warranted and imperative. Continued genetic analysis on samples obtained from gill net operations, creel clerks and the provincial government of British Columbia is necessary and strongly recommended.

4.4 A, Dam Entrainment

Further hydroacoustic sampling of entrainment at Grand Coulee Dam is highly recommended. Hydroacoustic sampling during 1996 counted a substantial number of fish (816,472) (Table 21) lost through 14 of 24 turbine intakes in a nine month period. Nineteen ninety seven entrainment was calculated at 322,933 fish (Table 221. During 1997, some turbine units at the third powerhouse that had large entrainment numbers in 1996 were down for maintenance or had disabled transducers (Table 23).

1996 was a record high water year and drum gate spill occurred for the first time in 20 years (Craig Sprankle per. Corn. 1997). Draft tube spill also occurred in conjunction with drum gate spill as part of a flood control effort. This project does not currently monitor entrainment through the drum gates or draft tubes. 1996 and 1997 entrainment figures do not include numbers from these two activities nor do they include entrainment through un-monitored turbine intakes. It is recommended that hydroacoustic sensing of fish entrainment through Grand Coulee Dam be continued for the following reasons; (1) Data collected from two un-equal time periods is insufficient for fishery managers to make necessary management decisions, (2) Several flow regimes and drawdown depth scenarios are necessary over a large range of reservoir conditions, (3) There is a large difference in entrainment between 1996 (high water year) and 1997 (low/moderate water year), (4) Continued hydroacoustic sensing of entrainment at Grand Coulee will enable better, more informed decisions by fishery managers, (5) Conclusions relating to the affect of hatchery origin fish on natural production may be reached in the analysis of the hydroacoustic data in conjunction with the species composition study being conducted in the forebay area.

Presently, Colville Tribal Fish and Wildlife staff is discussing with BioSonics Inc. the possibility of collecting entrainment data at a single drum gate location and the two un-monitored units at the third powerhouse.

4.4 B Species Identification.

Data clearly shows a month by month specie progression in both years of the study. The continuation of the gill net survey is recommended for another two year period. If after an additional two years of data collection, yearly percentages and progression are similiar then we would evaluate the necessity of continuing this phase of the objective.

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ATTACHMENT A;

1997 GENETIC ANALYSIS LETTERS TO Richard LeCaire FROM DR. ROBB LEARY

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March, 28, 1997

Richard LeCaire
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Nespelem, WA. 99155

Rich:

We have completed the electrophoretic analysis of the kokanee salmon, *Oncorhynchus nerka,* collected from the Nespelem River (N=17) and the San Poil River (N=10) in the fall of 1995. Horizontal starch gel electrophoresis was used to determine each fish's genetic characteristics at 45 loci (genes) coding for proteins present in muscle, liver, or eye tissue (Table 1).

The first issue to address is weather or not there is any evidence of genetic differences between fish from the two rivers. Evidence of genetic variation was detected at five loci in the samples (Table 2). Contingency table chi-square analysis did not indicate any statistically heterogenous allele frequency differences at these loci between the samples (Table 2). Thus, there is no evidence of genetic differences between fish from the two rivers.

The small sample sizes greatly weaken our ability to detect genetic differences between populations. We cannot conclude, therefore, from the analysis that fish in the Nespelem and San Poil rivers are genetically identical. What we can conclude, however, is that if genetic differences exist between then the differences are relatively small. This suggests either the two populations have recently been established from a common source or there is significant genetic exchange from the San Poil to the Nespelem population.

The next issue to address is how do the Nespelem/San Poil kokanee compare to other kokanee salmon populations. We have comparable electrophoretic data from ten other kokanee populations: New Fork Lake, Wyoming; Granby Reservoir, Colorado; Ashley Lake, Swan Lake, Little Bitterroot Lake, Lake Mary Ronan, and the Kootenai River, Montana; North Arm, West Arm, and central portion of Kootenai Lake, British Columbia. Note all of these additional are from non-native populations. Furthermore, all of the Montana lake populations were established from fish in Flathead Lake, Montana which in turn originated from the Quannat Salmon Hatchery, Oregon.

Evidence of genetic variation was detected at ten loci among all the samples (Table 3). Contingency table chi-square analysis indicated that the allele frequencies are statistically heterogenous among the samples at seven of these loci (Table 3). Thus, there is strong evidence that genetic differences exist among the populations. What distinguishes the Nespelem/San Poil population from most of the others is the very low frequency of *ALAT*-2*90 and the very high frequency of *PGM*-1*null.

Finally, we compared the genetic characteristics of the Nespelem/San Poil kokanee to those in Lake Whatcom. Lake Wenatchee, and the Okanogan River using data presented by Winans et al. (1996). Between the two studies, 32 loci were analyzed in common of which ten showed evidence of genetic variation among the samples (Table 4). These data provide strong evidence that genetic difference exist among the four populations as the allele frequencies are statistically heterogenous among the samples at five of the ten variable loci (Table 4). Again what mainly distinguishes the Nespelem/San Poil fish from the others is the low frequency *of* *ALAT**90 and the high frequency of PGM-1*null. Furthermore, the Nespelem/San Poil fish appear to possess unique variant alleles at *GPI-A*, LDH-Bl**, and *LDH-C** (Table 4). Taken together these differences are not compatible with the premise that fish from Lake Whatcom, Lake Wenatchee or the Okanogan River have has a recent substantial genetic contribution to the Nespelem/San Poil population. Rather these differences indicate a fairly long period of complete or nearly complete reproductive isolation,

Sincerely

Robb Leary

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Winans, G. A., P. B. Aebersold, and R. S. Waples. 1996. Allozyme variability of *Oncorhynchus* nerka in the Pacific Northwest, with special consideration to populations of Redfish Lake, Idaho. Transactions of the American Fisheries Society 125:645-663.

Table 1

Loci and enzymes examined. E = eye, L = liver, M = muscle.

Enzyme	Loci	Tissue
Adenylate kinase	AK -1, 2*	M
Alanine aminotransferase	ALAT*	M
Alcohol dehydrogenase	ADH*	
Aspartate aminotransferase	sAAT-1*, sAAT-2*, sAAT-3,4*	L
Creatine kinase	CK-A1*, CK-A2*, CK-B*, CK-Ci*, CK-C2*	E
Dipeptidase	PEPA*	E
Glucose-6-phosphate dehydrogenase	GPI-A*, GPI-B1*, GPI-B2*	M
Glyceraldehyde-3-phosphate dehydrogenase	GAPDH-3*, GAPDH-4*	E
Glycerol-3-phosphate dehydrogenase	G3PDH*	L
Iditol dehydrogenase	IDDT-1*, IDDH-2*	L
Isocitrate dehydrogenase	mIDHP-1*, mIDH-2*,sIDHP-1*, sIDHP-2*	M L
Lactate dehydrogenase	LDH-A1*, LDH-A2*, Ldh-B1*, LDH-B2*, LDH-C*	M E
Malate dehydrogenase	sMDH-A1,2* sMDH-B1,2*	L M
Malic enzyme	mMEP-1*, mMEP-2*, sMEP-1*, sMEP-2*	M
Phosphoglutcomutase	PGM-1*, PGM-2*	M
Phosphogluconate dehydrogenase	PGDH*	M
Superoxide dismutase	sSOD-1*	L
Tripeptide aminopeptidase	PEPB8	E
Xanthine dehydrogenase like	XDH7*	L

Table 2

Allele frequencies at the loci showing evidence of genetic variation in samples of kokanee salmon from the Nespelem and San Poil Rivers. X^2 = contingency table chi-square statistic for heterogeneity of allele frequencies between samples. D.f. = Degrees of freedom.

Sample and allele frequencies

Locus	Alleles	Nespelem	San Poil	X^2	D.f.
ALAT-2*	100	0.529	.650	1.111	2
	97	0.441	0.300		
	90	0.029	0.050		
GPI-A*	107	.962	1.0	.7770	1
	110	0.038	-	-	
LDH-B1*	100	0.971	1.0	0.598	1
	null	0.029	-	-	
LDH-C*	103	0.971	1.0	0.598	1
	100	0.029	-	-	
PGM-2*	60	0.853	0.850	0.001	1
	80	0.147	0.150	-	-

Table 3

Allele frequencies at the loci showing evidence of genetic variations in sample of kokanee salmon. X^2 = Contingency table chi-square statistic for heterogeneity of allele frequencies among samples. D.F. = degrees of freedom. ***P<0.001

Sample and allele frequencies

Locus	Allele	Wyo	Col	Ashley	Swan	B.Root	M Ronan
sAAT-3,4*	100	1.000	1.000	1.000	1.000	1.000	1.000
	85	-	-	-	-	-	-
	110	-	-	-	-	-	-
ALAT-2*	100	.622	.390	.375	.370	.500	.469
	97	.173	.170	.417	.200	.200	.122
	90	.204	.440	.208	.430	.300	.408
GAPDH-4*	100	1.000	1.000	1.000	1.000	1.000	1.000
	null	-	-	-	-	-	-
GPI-A*	107	1.000	1.000	1.000	1.000	1.000	1.000
	100	-	-	-	-	-	-
LDH-A2*	100	.620	1.000	1.000	1.000	1.000	1.000
	120	.380	-				

Table 3-continued

Locus	Allele	Kootenai River	Kootenai Lake North	West	Cent.	N./SP	X^2	D.f.
sAAT-3,4*	100	1.000	.992	1.000	.985	1.000	22.97	20
	85	-	.004	-	.015	-		
	110	-	.004	-	-	-		
ALAT-2*	100	.460	.517	.913	.588	.574	116.057***	20
	97	.200	.225	.022	.176	.389	-	-
	90	.340	.258	.065	.235	.037	-	-
GAPDH-4*	100	.960	1.000	1.000	1.000	1.000	34.433***	10
	null	.040	-	-	-	-	-	-
GPI-A*	107	1.000	.950	1.000	.912	.978	45.0***	10
	110	-	.050	-	.088	.022		
LDH-A2*	100	1.000	1.000	1.000	.926	1.000	273.813***	10
	120	-	-	-	.074	-	-	

Table 3-continued

Sample and allele frequencies

Locus	Allele	Wyo	Col	Ashley	Swan	L. Bitter	M. Ronan
LDH-B1*	100	1.000	1.000	1.000	1.000	1.000	1.000
	null	-	-	-	-	-	-
LDH-C*	103	1.000	1.000	1.000	1.000	1.000	1.000
	110	-	-	-	-	-	-
mMEP-1*	100	.900	1.000	1.000	1.000	1.000	1.000
	95	0.100	-	-	-	-	-
PGM-1*	100	1.000	1.000	1.000	1.000	1.000	1.000
	null	-	-	-	-	-	-
PGM-2*	60	**.960**	.700	.865	.800	**I.840**	.806
	80	.040	.300	.135	.200	.160	.194

	40						

Table 3-continued

Sample and allele frequencies

		Kootenai	Kootenai Lake					
Locus	allele	River	North	West	Cent.	Nesp/ SP	X^2	D.f.
LDH-B1*	100	1.000	1.000	1.000	1.000	.981	15.68	10
	null	-	-	-	-	.019		
LDH-C*	103	1.000	1.000	1.000	1.000	.981	15.68	10
	110	-	-	-	-	.019	-	
mMEP-1*	100	1.000	1.000	1.000	1.000	1.000	79.386***	10
	95	-	-	-	-	-	-	
PGM-1*	100	.368	.588	.639	.358	-	237.479***	10
	null	.632	.412	.361	.642	1.000		
PGM-2"	60	.920	.875	.970	.912	.852	48.242***	10
	80	.080	.117	.109	.088	.148		
	40	-	.008	.022	-			

Table 4

Allele frequencies at the loci analyzed in common and showing evidence of genetic variation in samples of kokanee from the Nespelem/San Poil Rivers, Lake Whatcom, Lake Wenatchee and the Okanogan River. X^2 and D.f. as in Table 2. *=P<0.05, ***=P<0.001.

Sample and allele frequencies

LOCUS	Allele	Nesp.	Whatc	Wenatc	Okan	X^2	D.f.
ALAT*	100	.574	.398	.844	.429	167.14 ***	9
	108			.006	.206		
	97	.389	.331	.019	.119		
	90	.037	.271	.131	.246		
GPI-A*	107	.978	1.000	1.000	1.000	9.021"	3
	110	.022					
mIDHP_1*	100	1.000	.992	.956	1.000	10.283	3
	77		.008	.044			
mIDHP-2*	100	1.000	.992	1.000	1.000	2.854	3
	133		.008				
LDH-B1*	100	.981	1.000	1.000	1.000	7.350	3
	null	.019					
LDH-C*	103	.981	1.000	1.000	1.000	7.350	3
	110	.019					
sMDH-B1,2*	100	1.000	.992	.981	.905	25.280 *	6
	120		.008				
	65			.091	.095		

Table B-continued

Samwle and allele frequencies

Locus	Allele	Nespel	Whatco	Wenatc	Okan	X^2	D.f.
PGM-1"	100	-	.572	.500	.496	65.366 ***	3
	null	1.000	.428	.500	.504		
PGM-2*	60	.852	.858	.750	.754	7.178	3
	80	.148	.142	.250	.246		
sSOD-1*	100	1.000	1.000	969	.992	6.608	3
	145			.031	.008		

APPENDIX I:

1997 Chief Joseph Kokanee Project
Screw Trap Data

DATE	TIME	SPECIE	LENGTH	WEIGHT	TEMP.	COMMENT
3/17	10:15	TRAP	OFF			HI-WAT
4/9	10:30	RBT	170 mm	62.1 g	7 C	DEBRIS
		RBT	110	10.4	6 C	BLUE
		RBT	90	7.6		SKY
		BUR	50	2.1		
		BUR	45	1.3		
4/11	9:55	RBT	190	70.2	37.4 f	
		RBT	135	40.3		
		RBT	75	27.5		
		RBT	60	20.1		
		RBT	110	34.5		
		RBT	35	11.7		
4/12	8:13	RBT	160 mm	60.6	37.4 f	
		RBT	80	29.3		
		RBT	65	21.2		
		RBT	25	6.8		
		RBT	145	32		
		RBT	120	21		
		RBT	85	5.3		
		RBT	150	34		
4/14		RBT	105	32		

4/10	10:20	RBT	190	64.2		
		RBT	165	42.7		
		RBT	100	9.5		
		RBT	85	5.6		
4/10	10:20	RBT	88	6		
		SCU	100	12.6		
		SCU	60	2.4		
		SCU	70	3.3		
4/14	11:54	RBT	115	25.4	40.6	Hi-FL
4/15	10:25	SCU	110 MM	22.1		
		SCU	80	11.3		
		RBT	195	66.2		
		RBT	210	75.8		
		RBT	65	8.3		
4/16	9:15	RBT	110 MM	35 G.		
		SCU				
		SUC				
		SUC				
4/17	OUT	OF	SERVICE	AT	10:15	
6/12	NEW	TRAP	IN	SERVICE		
6/13	9:00	RBT	159 mm	27 G.		
		RBT	85	5		
		RBT	137	26		
		RBT	114	6		
6/14	1:45	RBT	145	38		SUNNY
6/15	1:59	RBT	125	17		

		RBT	121	14		
		RBT	138	30		
		RBT	125	21		
		RBT	114	18		
		SUC	114	16		
		RBT	104	12		
		SUC	118	21		
		RBT	100	10		
		SUC	85	7		
		SUC	94	8		
		SUC	86	5		
		SUC	95	8		
		SCU	(4)			
6/16	9:56	RBT	155	45		
		RBT	140	36		
		RBT	170	51		
		RBT	140	25		
		RBT	135	27		
		RBT	130	25		
		RBT	120	17		
		RBT	122	19		
		RBT	128	22		
		RBT	118	15		
		SUC	113	13		
		SUC	120	20		
		DA	115	18		

		RBT	105	10		
		SUC	113	14		
		RBT	110	11		
		RBT	110	14		
		RBT	122	18		
		SUC	108	14		
		SUC	90	7		
		SUC	115	13		
		RBT	100	9		
		SUC	66	3		
		SUC	94	8		
		SUC	92	7		
		SUC	87	6		
		DA	57	2		
		DA	46	1		
6/16	19:25	RBT	132 mm	24 G.		
		RBT	147	32		
		DA	110	15		
		RBT	100	13		
		RBT	95	9		
		RSS	110	15		
		RSS	86	5		
6/17	10:15	SUC	(5)			
		RSS	(1)			
6/18		RBT	104	10	CLIP	Blue sky
		RBT	140	29	CLIP	

		RBT	68	3	CLIP	
		RBT	136	23	CLIP	
		RBT	155	41	CLIP	
		RBT	128	23	CLIP	
		RBT	134	25	CLIP	
		RBT	158	41	CLIP	
		RBT	132	24	CLIP	
		RBT	98	8	CLIP	
		RBT	90	6	CLIP	
		RBT	131	18	CLIP	
		RBT	103	12	CL	
		RBT	113	12	CL	
6/19	10:25	RBT	123	20	CL	
		RBT	121	15	CL	
		RBT	110	13	CL	
		RBT	160	44	CL	
		RBT	124	21	CL	
		RBT	98	7	CL	
		RBT	107	10	CL	
		RBT	110	11	CL	
		RBT	120	20	CL	
		RBT	94	5	CL	
		SUC	(16)			
		PMM	(1)			
6/21	12:45	SUC	(30)			
		DA	(10)			

6/22	11:30	SUC	(11)			
6/23	10:35	SUC	(24)			
		PMM	(7)			
		DA	(1)			
		SCU	(1)			
		RBT	126	19	CLIP	
		RBT	124	19	CL	
		RBT	124	22	CL	
		RBT	98	9	CL	
		RBT	115	17	CL	
		RBT	143	29	CL	
		RBT	116	16	CL	
		RBT	143	30	CL	
		RBT	186	68	CL	
		RBT	145	34	CL	
		RBT	118	13	CL	
		RBT	121	17	CL	
		RBT	123	17	CL	
		RBT	96	9	CL	
		RBT	139	29	CL	
		RBT	173	51	CL	
		RBT	81	6	CL	
6/24	9:30	SUC	(51)			
		RBT	96	7	CL	
		RBT	77	4		
		RBT	103	12	"	

		RBT	78	4	''	
		RBT	95	8	''	
		RBT	115	15	''	
		RBT	118	20	''	
		RBT	142	27	''	
		RBT	142	29	''	
		RBT	130	23	''	
		RBT	166	54	''	
		RBT	143	33	''	RECAP
6/25		RBT	142	29	''	
		RBT	114	14	''	
		RBT	138	30	''	
		RBT	78	2	''	
		RBT	112	14	''	
		RBT	103	10	''	
		RBT	115	14	''	
		RBT	121	20	''	
		RBT	99	8	''	
		RBT	99	8	''	
		RBT	98	9	''	
		RBT	158	43	''	
		RBT	192	75	''	
6/26		RBT	114	16	''	
		RBT	130	20	''	
		RBT	107	10	''	
		RBT	113	13	''	

		RBT	132	20	''	RECAP
		RBT	114	16	''	DOA
		RBT	97	8	''	
		RBT	76	4	''	
		RBT	123	19	''	
		RBT	96	12	''	
		RBT	121	20	''	
		RBT	134	25	''	
		RBT	104	12	''	
		RBT	73	5	''	
		RBT	115	17	''	
		RBT	109	13	''	
		RBT	124	20	''	
		RBT	111	8	''	
		RBT	147	34	''	
		RBT	131	24	''	
		RBT	142	28	''	
		RBT	166	48	''	
		RBT	74	4	''	
		RBT	129	22	''	
		RBT	86	6	''	
		RBT	133	23	''	
		RBT	124	19	''	
		RBT	129	23	''	
		RBT	101	10	''	
		RBT	135	25	''	

		RBT	112	14	''	
		RBT	129	24	''	
		RBT	124	16	''	
		RBT	110	15	''	
7/04		13	CAPT		HELD	
7/05		6	CAPT		HELD	
7/06		RBT	148			
		RBT	96			
		RBT	113			
		RBT	94			
		RBT	24			
7/07		RBT	110	12	CLIP	
		RBT	113	1`1	''	
		RBT	100	4	''	
		RBT	102	8	''	
		RBT	141	27	''	
		RBT	100	9	''	
		RBT	150	34	''	
		RBT	119	16	''	
		RBT	113	12	''	
		RBT	87	6	''	
		RBT	88	8	''	
		RBT	134	23	I ,	
		RBT	87	6	I I	
		RBT	123	17	''	
		RBT	99	10	I ,	

		RBT	123	21	''	
		RBT	195	79	''	
		RBT	147	32	''	
		RBT	130	22	''	
		RBT	110	11	''	
		RBT	95	10	''	
		RBT	135	28	''	
		RBT	113	15	''	
		RBT	124	23	''	
		RBT	93	8	''	
		RBT	96	9	''	
		RBT	105	11	''	
		RBT	94	7	''	
		RBT	118	13	''	
		RBT	83	6	''	
		RBT	78	4	''	RECAP
7/11		RBT	119	16	UNCL	DEAD
		RBT	156	38	CLIP	
		RBT	108	13	''	
		RBT	105	11	''	
		RBT	134	27	''	
		RBT	114	15	''	
		RBT	129	22	''	
		RBT	113	14	''	
		RBT	148	33	''	
		RBT	110	16	''	

		RBT	132	19	''	
		RBT	138	31	''	
		RBT	89	10	''	
		RBT	128	32	''	
		RBT	109	13	''	
		RBT	65	3	''	
		RBT	111	15	''	
		RBT	91	9	''	
		RBT	124	21	''	
		RBT	77	5	''	
		RBT				
7/18		RBT	94	8	''	
		RBT	125	28	''	NO TAIL
		RBT	164	47	''	
		RBT	134	24	''	
		RBT	154	35	''	
		RBT	162	49	''	
		RBT	80	5	''	
		RBT	118	16	''	
		RBT	145	18	''	
		RBT	92	7	''	
		RBT	126	18	''	
		RBT	109	10	''	
		RBT	100	9	''	
		RBT	119	18	''	
		RBT	151	34	''	

		RBT	144	30	''	
		RBT	128	20	''	
		RBT	111	9	''	
		RBT	134	22	''	
		RBT	110	11	''	
		RBT	91	6	''	
		RBT	168	50	''	
		RBT	83	5	''	
7/19		RBT	129	23	''	
		RBT	110	15	''	
		RBT	111	10	''	
7/20		RBT	110	13	''	
		RBT	125	21	''	
7/21		RBT	152	35	''	
		RBT	134	28	''	
		RBT	114	17	''	RECAP
		RBT	120	20	''	
		RBT	100	9	''	
7/22		RBT	215	75		
		RBT	185	55		
		RBT	225	90		
		RBT	170	40		
		RBT	193	62		
		RBT	140	35		
		RBT	125	19		
		RBT	130	23		

		RBT	126	21		
7/23		RBT	133	25		
		RBT	138	28		
		RBT	133	23		
7/24		RBT	170	60		17 d C.
		RBT	140	26		
		RBT	134	25		
		RBT	140	27		
		RBT	159	33		
		RBT	120	18		
		RBT	143	28		
		RBT	108	13		
		RBT	165	46		
		RBT	148	22		
		RBT	154	38		
		RBT	148	34		
7/25		RBT	144	39		
		RBT	183	69		
		RBT	128	21		
7/26		RBT	123	16		
		RBT	135	25		
		RBT	144	27		
		RBT	115	11		
		RBT	185	72		
		RBT	170	68		
		RBT	150	31		

		RBT	162	37		
		RBT	142	35		
		RBT	147	29		
7/27		RBT	159	41		
		RBT	134	20		
		RBT	149	33		
		RBT	167	47		
		RBT	123	21		
		RBT	124	21		
7/28		RBT	151	33		
		RBT	145	31		
		RBT	124	19		
		RBT	148	37		
		RBT	131	25		
		RBT	127	18		
		RBT	147	34		
		RBT	168	46		
		RBT	168	44		
		RBT	166	47		
		RBT	149	34		
		RBT	206	81		
		RBT	114	16		
		RBT	122	17		
		RBT	125	17		
		RBT	82	5		
7/29		RBT	143	26		

		RBT	169	48		
		RBT	154	35		
		RBT	126	22		
		RBT	144	35		
		RBT	123	18		
		RBT	82	6		
		RBT	121	16		
7/30		RBT	160	47		
		RBT	147	30		
		RBT	100	11		
		RBT	142	30		
7/31		RBT	144	33		
		RBT	133	24		
		RBT	125	20		
		RBT	110	11		
8/01		RBT	100	11		
		RBT	125	21		
		RBT	131	23		
8/02		RBT	175	53		
		RBT	155	39		
		RBT	60	1		
8/03		RBT	123	20		
		RBT	110	13		
8/04		RBT	165	48		
8/05		RBT	145	37		
		RBT	28	6		

		RBT	14	2		
8/06		RBT	115	23		
		RBT	35	8		
8/07		RBT	185	60		
		RBT	35	8		
8/08	OUT	OF	SERVICE			

Legend;

KOK Kokanee (*Oncorhynchus nerka*)
RBT Rainbow trout (*Oncorhynchus mykiss*)
SUC Sucker family
scu Sculpin family
DAC Dace family
PMM Pike mouth minnow
RSS Red side shiner *(Richardsonius balteatus)*
BUR Burbot (Lota lota)

APPENDIX II SAN POIL ADULT TRAP DATA

Date	Specie	Lenuth	Weiaht	Oriq.	Sex	Cond.	Comment
8/18	Weir installed Water temp.						20 deg. C.
8/19	No fish						19 deg. C.
8/20	No fish						16.5 deg.
8/21	No fish						15 deg C.
8/22	No fish						14 deg.
8/26	NO fish						la deg. c
8/27	No fish						15.5
8/29	No fish						13
8/30	KOK	254 m/m	240 g.				Dead on Weir
9/1	KOK			H	M		Dead on weir
9/4	KOK	400 m/m	?	H	F	Poor	Took head
9/10	KOK	355 M/M	496.5	W	F		DOW, 13 C.
9/11	SUC						DOW, 15 C.
9/14	KOK	268 m/m	238 g.	H	F		DOW
9/14	KOK	293 m/m	570 g.		F	Colored,	No tail DOW
9/17	No fish	Lots of leaves, windy, partly cloudy					14 c.
9/18	No fish	Partly Sunny					14.5 c.
9/24	No fish	Blue sky,					12.5 C.
9/25	No fish	Blue sky					11 c.
9/27	No fish	Dead sucker on weir, partly cloudy.					14 c.
9/29	No fish	Sunny, blue sky					14 c.
9/30	No fish	Cloudy,					14 c.
10/1	No fish	Cloudy, lots of debris on weir					14 c.